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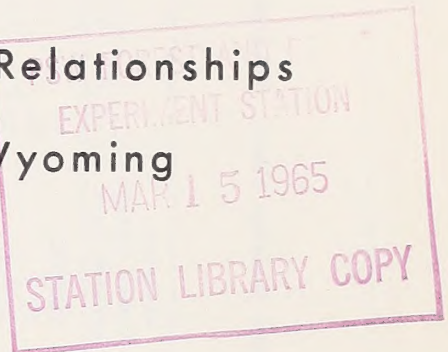
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Taper Tables, Bark Thickness, and Diameter Relationships for Lodgepole Pines in Colorado and Wyoming

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The taper tables and linear relationships presented here may be used to estimate:

1. Diameter inside bark at various heights with tree heights in feet or logs,
2. Double bark thickness at breast height,
3. Past diameter outside bark when present diameter and radial wood growth are known,
4. Diameter outside bark at breast height when only stump diameter is available for measurement.

The tables and relationships are based on measurements of 810 lodgepole pines (*Pinus contorta* Dougl.) located throughout Colorado and Wyoming. The results apply to trees 3 to 25 inches diameter at breast height except where other ranges are specified.

Taper Tables

Diameters inside bark at intervals of 8.15 feet above stump height (1.0 foot) are given in the taper tables. They are reported as scaling diameters of logs (16.3 feet) and half-logs (8.15 feet) when tree heights are in logs to a

¹Research Forester, Rocky Mountain Forest and Range Experiment Station, with central headquarters maintained at Fort Collins, in cooperation with Colorado State University.

6- or 8-inch top (tables 1, 2). Diameters are given to the nearest 0.1 inch when tree heights are in feet (table 3). Diameters at stump height and at breast height (4.5 feet above ground level) are also reported when tree heights are in feet.

Merchantable height is the maximum number of logs and half-logs between the stump and the specified top diameter. Portions of the bole above the height of minimum top saw log diameter were included in the uppermost log or half-log if the standard length (8.15 or 16.3 feet) ended within 4.0 feet above this height. This is the reason for occasional entries of 5 inches in table 1 and of 7 inches in table 2.

Bark Thickness

Differences between diameters inside and outside bark at breast height (table 3) are measures of double bark thicknesses. Bark thickness may be computed from the following linear relationship:

$$T = 0.038 (\text{d.b.h.}) + 0.115$$

$$[r = 0.992 \quad S_{yx} = 0.018]$$

where T is double bark thickness at breast height and d.b.h. is diameter outside bark 4.5 feet above ground level.

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Table 3.--Diameters at various heights of the average tree in each total height and diameter class.

| Total height (Feet) | Diameter : breast height : outside bark : (Inches) | Height above ground level in feet | | | | | | | | | | | |
|---------------------------|--|-----------------------------------|------|------|------|------|------|------|------|------|------|------|------|
| | | 1.0 | 4.5 | 9.2 | 17.3 | 25.4 | 33.6 | 41.8 | 49.9 | 58.0 | 66.2 | 74.4 | 82.5 |
| | | Diameter inside bark in inches | | | | | | | | | | | |
| 30.0 | 3.5 | 3.5 | 3.2 | 3.1 | 2.4 | 1.1 | | | | | | | |
| | 4.5 | 4.6 | 4.2 | 3.9 | 3.1 | 1.2 | | | | | | | |
| | 5.5 | 5.7 | 5.2 | 4.6 | 3.8 | 1.3 | | | | | | | |
| | 6.5 | 6.8 | 6.1 | 5.4 | 4.5 | 1.4 | | | | | | | |
| | 7.5 | 7.9 | 7.1 | 6.2 | 5.2 | 1.5 | | | | | | | |
| 40.0 | 3.5 | 3.5 | 3.3 | 3.1 | 2.7 | 2.3 | 1.3 | | | | | | |
| | 4.5 | 4.6 | 4.2 | 4.0 | 3.5 | 2.7 | 1.5 | | | | | | |
| | 5.5 | 5.7 | 5.2 | 4.9 | 4.2 | 3.5 | 1.7 | | | | | | |
| | 6.5 | 6.8 | 6.1 | 5.8 | 5.0 | 4.2 | 2.0 | | | | | | |
| | 7.5 | 7.9 | 7.1 | 6.7 | 5.8 | 4.8 | 2.2 | | | | | | |
| | 8.5 | 9.0 | 8.1 | 7.5 | 6.6 | 5.4 | 2.4 | | | | | | |
| | 9.5 | 10.1 | 9.0 | 8.4 | 7.4 | 6.0 | 2.6 | | | | | | |
| | 10.5 | 11.2 | 10.0 | 9.3 | 8.1 | 6.6 | 2.9 | | | | | | |
| | 11.5 | 12.3 | 11.0 | 10.2 | 8.9 | 7.2 | 3.1 | | | | | | |
| | 12.5 | 13.3 | 11.9 | 11.1 | 9.7 | 7.8 | 3.3 | | | | | | |
| | 4.5 | 4.6 | 4.2 | 4.1 | 3.6 | 3.2 | 2.4 | 2.1 | | | | | |
| | 5.5 | 5.7 | 5.2 | 5.0 | 4.4 | 4.0 | 3.2 | 2.4 | | | | | |
| | 6.5 | 6.8 | 6.1 | 5.9 | 5.2 | 4.7 | 3.9 | 2.7 | | | | | |
| 50.0 | 7.5 | 7.9 | 7.1 | 6.8 | 6.0 | 5.3 | 4.5 | 3.0 | | | | | |
| | 8.5 | 9.0 | 8.1 | 7.6 | 6.9 | 6.0 | 5.2 | 3.2 | | | | | |
| | 9.5 | 10.1 | 9.0 | 8.6 | 7.7 | 6.8 | 5.8 | 3.4 | | | | | |
| | 10.5 | 11.2 | 10.0 | 9.5 | 8.4 | 7.5 | 6.5 | 3.6 | | | | | |
| | 11.5 | 12.3 | 11.0 | 10.4 | 9.2 | 8.3 | 7.1 | 3.8 | | | | | |
| | 12.5 | 13.3 | 11.9 | 11.3 | 10.0 | 9.0 | 7.6 | 4.0 | | | | | |
| | 13.5 | 14.5 | 12.9 | 12.1 | 10.7 | 9.6 | 8.1 | 4.2 | | | | | |
| | 14.5 | 15.7 | 13.8 | 12.9 | 11.4 | 10.2 | 8.6 | 4.4 | | | | | |
| | 15.5 | 16.8 | 14.8 | 13.7 | 12.0 | 10.7 | 9.1 | 4.6 | | | | | |
| | 16.5 | 18.0 | 15.8 | 14.5 | 12.7 | 11.2 | 9.6 | 4.8 | | | | | |
| | 17.5 | 19.1 | 16.7 | 15.2 | 13.3 | 11.7 | 10.2 | 5.0 | | | | | |
| | 18.5 | 20.3 | 17.7 | 16.0 | 13.8 | 12.2 | 10.6 | 5.2 | | | | | |
| | 5.5 | 5.7 | 5.2 | 5.1 | 4.7 | 4.3 | 3.7 | 3.1 | 1.8 | 0.7 | | | |
| | 6.5 | 6.8 | 6.1 | 6.0 | 5.5 | 5.1 | 4.5 | 3.6 | 2.2 | 0.8 | | | |
| | 7.5 | 7.9 | 7.1 | 6.9 | 6.4 | 5.8 | 5.2 | 4.2 | 2.6 | 0.8 | | | |
| 60.0 | 8.5 | 9.0 | 8.1 | 7.8 | 7.2 | 6.6 | 5.9 | 4.8 | 3.0 | 0.9 | | | |
| | 9.5 | 10.1 | 9.0 | 8.7 | 8.0 | 7.3 | 6.5 | 5.3 | 3.5 | 1.0 | | | |
| | 10.5 | 11.2 | 10.0 | 9.6 | 8.9 | 8.1 | 7.2 | 5.8 | 3.9 | 1.1 | | | |
| | 11.5 | 12.3 | 11.0 | 10.5 | 9.8 | 8.9 | 7.8 | 6.3 | 4.2 | 1.1 | | | |
| | 12.5 | 13.3 | 11.9 | 11.4 | 10.4 | 9.5 | 8.4 | 6.8 | 4.6 | 1.2 | | | |
| | 13.5 | 14.5 | 12.9 | 12.2 | 11.1 | 10.1 | 8.9 | 7.3 | 4.9 | 1.3 | | | |
| | 14.5 | 15.7 | 13.8 | 13.0 | 11.8 | 10.7 | 9.4 | 7.8 | 5.3 | 1.4 | | | |
| | 15.5 | 16.8 | 14.8 | 13.8 | 12.7 | 11.5 | 10.3 | 8.6 | 5.7 | 1.5 | | | |
| | 16.5 | 18.0 | 15.8 | 14.7 | 13.3 | 12.2 | 10.9 | 9.1 | 6.1 | 1.6 | | | |
| | 17.5 | 19.1 | 16.7 | 15.2 | 13.8 | 12.2 | 10.6 | 8.6 | 6.5 | 1.7 | | | |
| | 18.5 | 20.3 | 17.7 | 16.0 | 13.8 | 12.2 | 10.6 | 8.6 | 6.5 | 1.7 | | | |

Estimation Of Past Diameter

Diameters inside and outside bark at breast height are related linearly, as follows:

$$D.i.b. = 0.9625 (d.o.b.) - 0.1141$$

$$[r = 0.999 \quad Syx = 0.077]$$

$$D.o.b. = 1.0377 (d.i.b.) + 0.1323$$

$$[r = 0.999 \quad Syx = 0.159]$$

where d.i.b. is diameter inside bark and d.o.b. is diameter outside bark.

These relationships may be used to determine past diameter outside bark. The steps are: (1) convert present d.o.b. to present d.i.b. with the first formula, (2) subtract twice the radial growth from present d.i.b. to obtain past d.i.b., and (3) convert past d.i.b. to past d.o.b. with the second formula. This accounts for the growth of both wood and bark.

The equations and a term for radial growth may be combined to produce this equation for direct estimation of past diameter:

Past d.o.b. = Present d.o.b. - 2.08 r + 0.01 (where r is radial wood growth at breast height for any desired period).

As indicated by the relationship between bark thickness and diameter, there is little change in bark thickness as diameter increases 1 inch. If periodic radial growth of the wood is 0.65 inch or less, past diameter out-

side bark equals present diameter outside bark minus twice radial wood growth. If radial wood growth is 0.70 to 2.00 inches, past diameter outside bark is 0.1 inch less than the difference between present diameter and twice radial wood growth.

Diameter Breast Height From Stump Diameter

Diameters outside bark at breast height may be estimated from diameters inside bark at the tops of stumps 1.0 foot high. The relationships are as follows:

If stump diameter inside bark is 3.0 to 13.9 inches:

$$D.b.h. = 0.9158 (d.i.b.) + 0.2781$$

$$[r = 0.998 \quad Syx = 0.135]$$

If stump diameter inside bark is 14.0 to 30.9 inches:

$$D.b.h. = 0.8735 (d.i.b.) + 0.7914$$

$$[r = 0.988 \quad Syx = 0.408]$$

Breast heights and corresponding stump diameter are shown in columns 2 and 3 of table 3. Sufficiently precise estimates of d.b.h. for other stump diameters than those given usually may be obtained by interpolation.

Estimates of d.b.h. from stump diameters may be used to compute the volumes of trees that have been cut and removed.

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